

Wireless Implementations of an Open Standard Sensor Bus

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Wireless Sensor Networks Are a Key Element of Industries of the Future

- What They Will Provide
 - Reduced Install Cost
 - Greater Flexibility
- What It Will Take
 - Short Term
 - » Higher Reliability
 - » Small, Fast and Cheap (Pick any two)
 - Long Term
 - » Improved Inter-System Compatibility (EMC/IT)
 - » Standardization

Who Needs Sensor Networks?

- Industry
- Science
- Military

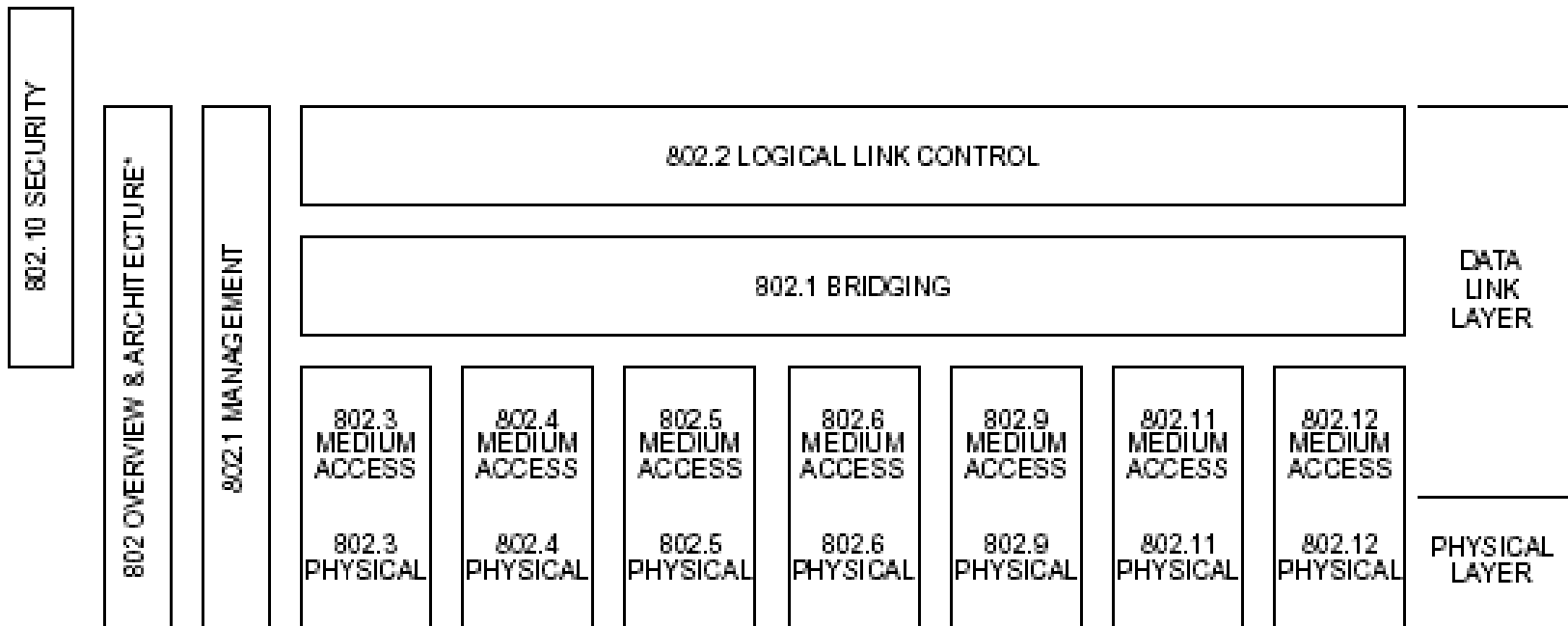
Standards Are Necessary to Reach Long-Term Goals

- Provide Commonly Accepted Infrastructure
- Can Evolve With Technology

So we will examine a couple of standards families --

IEEE 802 and IEEE 1451

The IEEE 802 Family Has Successfully Evolved With Technology



* Formerly IEEE Std 802.1A.

Candidate 1451 MAC/PHY

From Other Wireless Standards

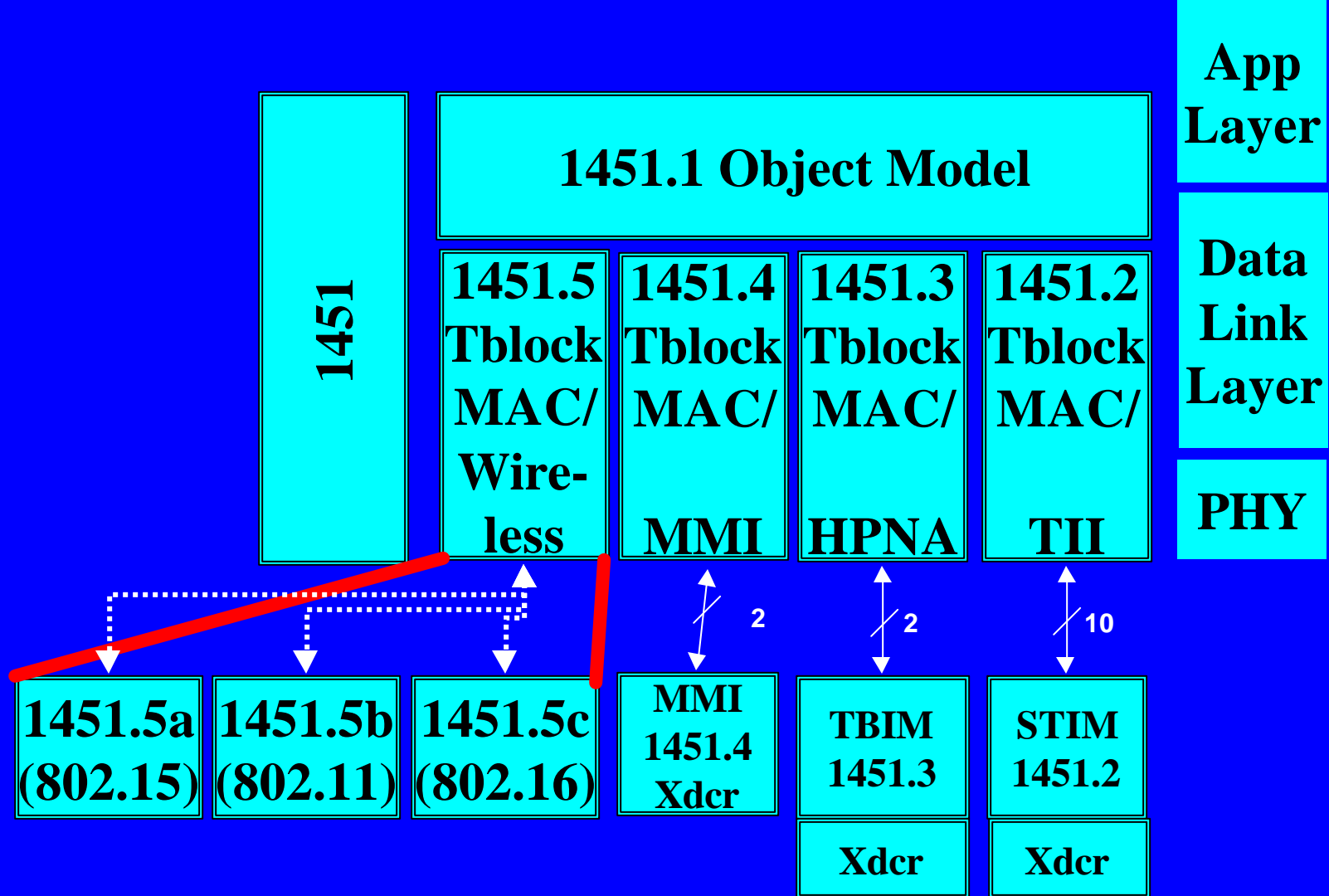
(Technology Issues)

Std	OFDM	FHSS	DSSS	GHz	Size	Mbps
IS-95			x	1 +/-	Cell	0.x
Bluetooth		x		2.45	PAN	1
P802.15		x		2.45	PAN	1
P802.16b	x			5	WAN	54
802.11a	x			5	LAN	54
802.11		x	x	2.45	LAN	1, 2
802.11b			x	2.45	LAN	5.5, 11

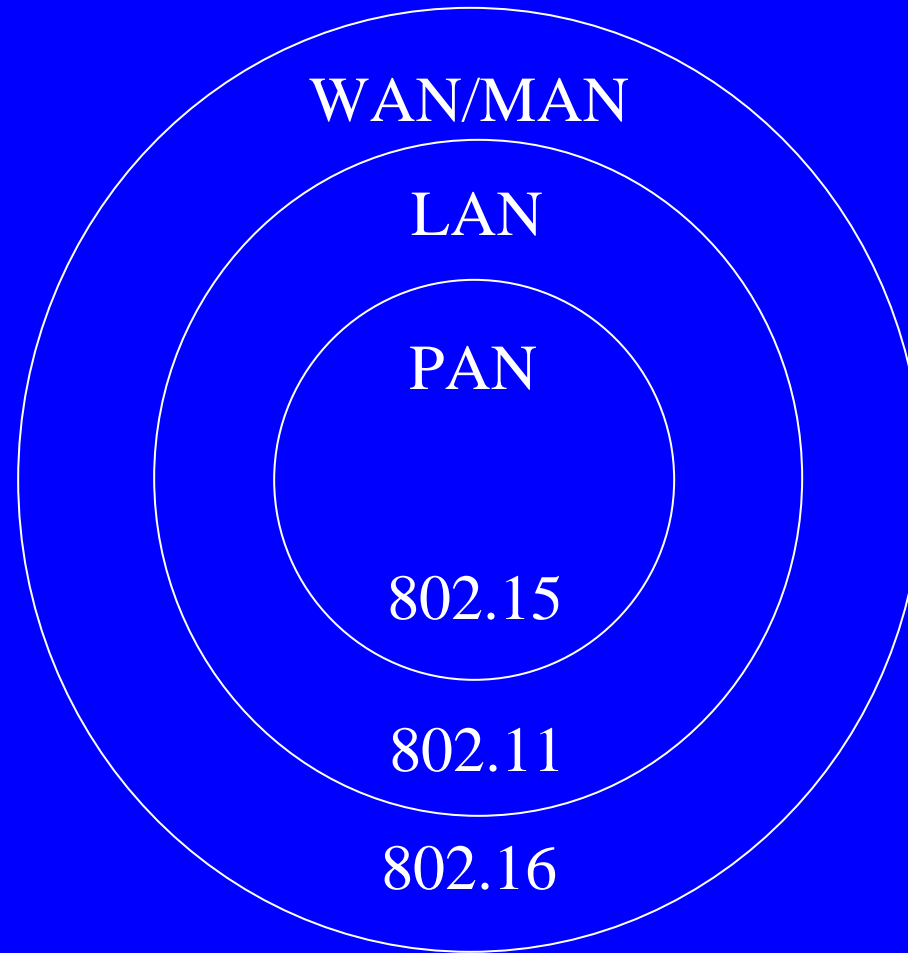
OFDM - Orthogonal Frequency Division Multiplexing

FHSS - Frequency Hopping Spread Spectrum

DSSS - Direct Sequence Spread Spectrum



Size of Network vs PHY



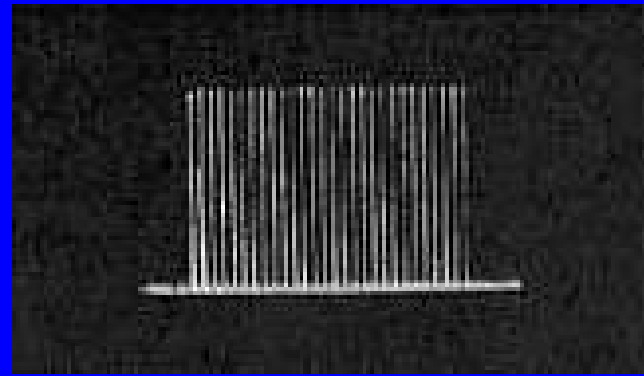
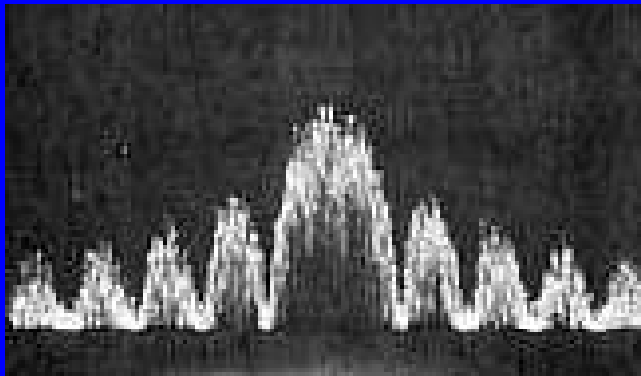
IEEE 802 Wireless Projects

- IEEE 802.15 (Bluetooth)
- IEEE 802.11
 - » Clause 14 - 1,2 Mbps FHSS LAN MAC for 2.4 GHz
 - » Clause 15 - 1,2 Mbps DSSS LAN for 2.4 GHz
- IEEE 802.11a
 - » Adds Clause 17 - ≤ 54 Mbps OFDM LAN for 5 GHz
- IEEE 802.11b
 - » Adds Clause 18 - 5.5 and 11 Mbps DSSS for 2.4 GHz
- IEEE 802.16b (task group 4) Wireless High-Speed Unlicensed Metropolitan Area Network (Wireless HUMAN)
 - » MAC: IEEE 802.16
 - » PHY: IEEE 802.11a; ETSI BRAN HIPERLAN/2

Finding the Right RF Technology for the Application

- Conventional Narrowband
- Frequency-Hopping Spread Spectrum
- Direct-Sequence Spread Spectrum
- Orthogonal Frequency Division Multiplexing

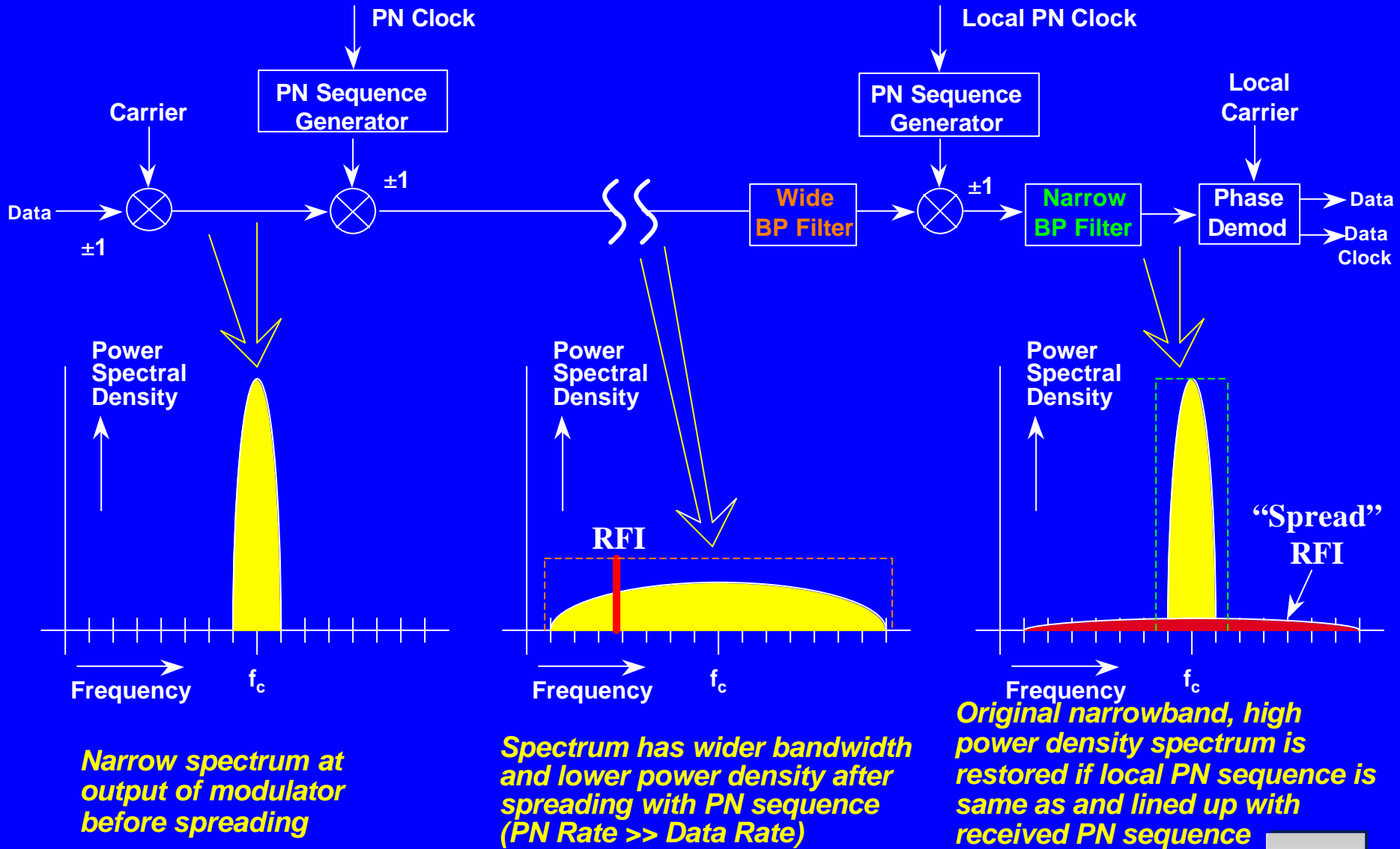
DSSS vs FHSS



Picking the Right Technology is Very Application Dependent

Typical Rank	Spectral Eff. (Bits/sec/Hz)	Non-interfering	Power Req'd	Data Reliability	Effective Range
Best	OFDM	DSSS	FHSS	OFDM	OFDM
Median	DSSS	FHSS	DSSS	DSSS	DSSS
Worst	FHSS	OFDM	OFDM	FHSS	FHSS

DIRECT-SEQUENCE SPREAD-SPECTRUM SIGNALS



Conclusions

- Wireless Sensor Networks Are a Key Part of Future Industries (and for the Military)
- Short-Term Goals Focus on Reliable Links and Reasonable Costs of Individual Systems so that Industries Will Accept Them.
- Long-Term Goals (Inter-System Compatibility) Require Standards Efforts and Improved RF Technologies.